R E P O R T R E S U M E S

ED 010 836 24

INDIVIDUAL DIFFERENCES IN STUDENT TENDENCIES TO PERSEVERE--MANIFESTATIONS OF NEURAL TRACE PERSISTENCE.

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REPORT NUMBER CRP-S-249 PUB DATE JAN 67
REPORT NUMBER BR-5-8025
CONTRACT OEC-5-10-451
EDRS PRICE MF-$0.18 HC-$2.44 61P.

DESCRIPTORS- *INDIVIDUAL DIFFERENCES, FACTOR ANALYSIS, NEUROLOGY, PSYCHOLOGY, EDUCATIONAL STRATEGIES, BEHAVIOR PATTERNS, *BEHAVIOR THEORIES, COLLEGE STUDENTS, *PERCEPTION, PERSONALITY, *LEARNING PROCESSES, THOUGHT PROCESSES, EDUCATIONAL IMPROVEMENT, *PSYCHOEDUCATIONAL PROCESSES, ANN ARBOR

THE CONCEPT OF PERSERVATION WAS EXTENDED TO A MORE NEURAL LEVEL TO INCLUDE PERSISTENCE OF TRACE ACTIVITY, AND A STUDY WAS MADE TO SEARCH FOR THE DIMENSIONS OF TRACE PERSISTENCE. THE STUDY WAS CONDUCTED TO IDENTIFY BEHAVIORAL DIFFERENCES OF INDIVIDUAL LEARNING PROCESSES AMONG STUDENTS. THE STUDY DID NOT TAKE THE TRADITIONAL PERSONALITY-MOTIVATION APPROACH TO INDIVIDUAL DIFFERENCES, BUT RATHER, WAS BASED ON A NEUROPSYCHOLOGICAL THEORY WHICH POSTULATES THAT NONSPECIFIC NEURAL ACTIVITY AND PARAMETERS OF SYNAPTIC TRANSMISSION PLAY VITAL ROLES IN MODULATING INDIVIDUAL TRACE ACTIVITY. DATA WERE OBTAINED ON SAMPLES OF UNDERGRADUATE COLLEGE STUDENTS, USING A VARIETY OF MEASURES OF MEMORY, PERCEPTION, COGNITION, ACADEMIC PERFORMANCE, AND SELF-ANALYSIS. A TOTAL OF 93 WOMEN PARTICIPATED INDIVIDUALLY IN THE INITIAL PHASE OF THE STUDY, AND 44 OF THESE RETURNED A YEAR AND A HALF LATER SO THAT CERTAIN RELIABILITY MEASURES COULD BE OBTAINED. IN ADDITION, 28 MEN SERVED AS SUBJECTS FOR GROUP-ADMINISTERED TESTS. NONMETRIC FACTOR ANALYSES WERE PERFORMED ON ALL GATHERED DATA. THE RESULTS SHOWED THERE ARE MEANINGFUL, ORDERLY DIFFERENCES IN THE WAYS STUDENTS PERCEIVE AND THINK. THE CONCLUSION WAS DRAWN THAT THE EDUCATION PROCESS MIGHT START WITH A KNOWLEDGE OF AND RESPECT FOR THE PATTERN OF DIMENSIONS CHARACTERISTIC OF EACH INDIVIDUAL. (AL)

ED010836

FINAL REPORT

Project No. S-249 (S-8025)
Contract No. OE-5-10-451

Individual Differences in Student Tendencies to Persevere: Manifestations of Neural Trace Persistence

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January 1967

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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INDIVIDUAL DIFFERENCES IN STUDENT TENDENCIES TO PERSEVERE/ MANIFESTATIONS OF NEURAL TRACE PERSISTENCE .

Project No. S-249
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Rachel Kaplan

January 1967

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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Acknowledgements

The first phase of this project began more than four years ago. During this time many people have been helpful in a variety of ways. The theory underlying this research has grown during this time, new ways of analyzing data have been developed. There is no room here to thank so many people.

Dr. James C. Lingoes' contributions have been many: he was always available, always patient, and very helpful. His nonmetric factor analysis is the basic tool that was used here to find meaning in complex data. But the tool without his further assistance would not have sufficed. Colleagues such as he are few and far between.

My husband, Stephen, and I work closely together in all our research activities. This project is no exception. In a sense, any work which bears the name of one of us could as well be co-authored.

CHAPTER I

Introduction

It is hardly newsworthy to say that college students differ from each other. They differ in abilities though they are selected to be relatively homogeneous in this respect. They differ in how readily they can memorize, in how readily they can come up with a correct answer to a straightforward question, in their capacity for producing a variety of answers to a given problem, in their speed of seeing things, in their cognitive strategies, in the ways they perceive themselves.

Recognition of such differences might facilitate the educational process. The student who performs poorly in the required introductory language course may spend the same amount of time, perhaps even more time, on his homework as does the student who leads the class. The same study habits may not fit all individuals in the same way. The popular SQ4R technique might provide helpful guidelines, but individuals may differ significantly in how long they should optimally spend on "reading", and whether "reciting" immediately after the "reading" maximizes their retention of the material. McKeachie et al (1964) have been studying the effects of matching student and teacher personalities on teaching and learning effectiveness.

The search for the relevant differences is the subject of this study. The research discussed here might be considered another in a long tradition of factorial studies of perception and personality. It differs from these in the broad data base reflected in the choice of the variables, in the particular analytic methods that were used, and in its origin in theory.

The concept of perseveration is seen as an important underlying dimension of behavior. Part of this involves perseveration as it is reflected in molar behavior, in persistence of conscious activity and reluctance to change activities midstream. But the concept of perseveration is used here also in the sense of persistence of trace activity, in other words, at a more neural level. It is relevant then to examine this perseveration concept -- its history of limelight, disillusionment, and its recent renaissance; its heritage from experimental, personality, and physiological psychology.

1. Perseveration literature

Historically, perseveration referred to the "tendency of a process to continue spontaneously for varying periods of time after cessation of the stimulus," (Levine, 1955, p. 108) but the emphasis was on abnormal extremes of such repetitive activity. The Austrian psychiatrist Otto Gross is considered the first to dimensionalize personality in terms of perseveration, which he called primary and secondary function. He characterized these processes in terms of "the activity of brain cells" in the "production of any form of mental content" (Gross, 1902,

as cited by Eysenck, 1960, p. 21) and concentrated on extreme cases of perseverative behavior evident in his patients. A few years later empirical study of perseveration as an individual difference dimension was begun by Wiersma and his collaborators of the Dutch School. Their tests were given to "maniacs, normals, and melancholiacs" and showed most secondary function (perseveration) in the last group and least in the "maniacs" (quoted in Spearman, 1927, p. 293).

This line of research on perseveration was soon continued by the English (or London) School headed by Spearman who, in 1927, proclaimed his "Law of lag or inertia: cognitive processes always both begin and cease more gradually than their (apparent) causes" (p. 291). He describes this law as a "generalization which combines ... two concepts that have put forward extraordinarily large claims" (p. 292): the work of Gross and the Dutch School on the one hand and the earlier work of Müller and Pilzecker who were concerned with the memorization of nonsense syllables.

Müller and Pilzecker (1900) referred to the "spontaneous recurrence" of a previously learned response as perseveration. To account for these instances of retroactive inhibition, Müller and Pilzecker postulated the "existence of a neural perseverative process, subject to external interference and requisite to the consolidation of the memory trace for recently acquired material" (quoted in Glickman, 1961, p. 218). Memory is thus strengthened by the added "practice" which perseveration provides.

Müller and Pilzecker's contribution lies not only in pointing to this important role that perseveration plays in learning, but in showing that normal individuals (Müller and his wife) varied greatly in the ability to "lay aside" nonsense syllable items between the learning session and the recall test a day later.

Perseveration research in the quarter century following Spearman's law involved samples of varying sizes, ages, mental health, and test items as well as variations in the administration and scoring of the tests and in the analysis of the resulting data (Kaplan, 1961). Spearman concluded in 1927 as a result of several studies that "there does appear to exist, as a unitarily functioning factor varying in degree from one individual to another, a tendency for mental processes to have a certain lag or inertia and in this meaning to 'perseverate'" (p. 306). But many other investigators since then (e.g., Hargreaves, 1927; Jasper, 1931; Shevach, 1937; Notcutt, 1943; and Walker et al., 1943) have failed to find a unique 'p' factor. Cattell (1946) postulated that two kinds of "inertias" -- of mental processes and of structural dispositions -- are involved. However, evidence for such a dichotomy is also equivocal (Rim, 1955).

In the last decade the concept of perseveration has received support from rather different areas of research. Both Deutsch (1962) and Glickman (1961) have recently reviewed the perseverative consolidation literature, citing the considerable support for this position in a variety of experimental settings. Additional evidence has been obtained using electroconvulsive shock (Fledman & Neet, 1960; Hudspeth et al., 1964; McGaugh & Madsen, 1964; Weissman, 1963, 1964), anesthesia

(Pearlman et al., 1961) and drugs (Breen & McGaugh, 1961; Paré, 1961; Doty & Doty, 1964).

In studies such as these, "the basic supposition is that reverberatory activity maintains the memory until the permanent changes underlying fixation of the trace have been completed" (Glickman, 1961, p. 229). A dual process of this sort is incorporated into Hebb's neural circuit model and has received added support from Burns' work (cited by Glickman). It is doubtlessly Hebb's theoretical work (1949, 1958) that has led to the blossoming of research on perseveration.

2. Neurochemicals and the extended perseveration theory

A mechanism for dealing with individual differences in perseveration would considerably enhance the predictive power and scope of this approach. Recent developments in neurochemistry suggest just such a mechanism. As Glickman (1961) points out, a mechanism based on synaptic changes is certainly credible given our present state of knowledge. More specifically, a possible determinant for such differences is provided by the substances which mediate neural transmission. Acetylcholine (ACh), and Cholinesterase (ChE) have been amply shown to be agents in synaptic transmission in the central nervous system and in the cortex. McLennan's (1963) and Eccles' (1964) books are devoted to reviewing the pertinent physiological evidence on synaptic transmission. They also deal extensively with inhibitory transmission, an area of increasing interest to the neurophysiologist. The intensity and duration of the perseverative process must depend at least in part on the availability of these substances. Thus if there are individual differences in the supply and production of these neurochemicals one would expect these differences to be reflected in the characteristics of each individual's perseverative activity. In his thought-provoking book, Biochemical Individuality, Williams (1956) leaves little doubt as to the existence of such differences. Reeves' (1966) review also provides ample support for this from animal studies, drug studies, and research in psychopathology. (It should be noted here that the theory in no way depends upon particular synaptic substances, but this greater specificity broadens the range of potentially relevant data.)

The extended perseveration theory motivating the present project is based on a conceptual neurophysiology. It says, like any perseveration theory, that learning is facilitated by self-sustained neural activity that persists after a trial or stimulus presentation. It further postulates that nonspecific neural activity (arousal) and parameters of synaptic transmission play vital roles in modulating the perseverative activity.

Predictions from such a theoretical position are not that all students (indeed all people) can be dimensionalized on a single 'p' dimension, that they are synthesizers or analyzers, perseverators or nonperseverators. Rather such a model leads to predictions of a variety of dimensions based on parameters of trace activity such as the time course of such activity and the readiness with which competing input will be processed. At least one of these dimensions is expected to relate to persistence in molar activities, or lag in the sense of difficulty with interrupting a started project. Other dimensions will pre-

sumably deal with more molecular manifestations of trace activity.

3. Objectives of the present study

Conceptualized in this way, it becomes clear that the traditional tasks used in the quest for the 'p' factor were indeed limiting and even ill-conceived. A majority of them are basically motor, and even the ones that are termed "creative effort" (after Cattell) involve such over-learned components that they are more closely related to a motor skill. One of the creative effort tests, for example, involves writing "lmnopq" repeatedly for some time and then these letters have to be written in reverse order for the same length of time (Jasper, 1931). Another task involves copying a passage but doubling each letter (Cattell, 1946). Given tasks of this kind it is hardly surprising that the two grouping proposed by Cattell often failed to discriminate.

Studies in this domain have involved mostly motor tests, occasional cognitive tasks, and some self-report inventories (Kaplan, 1961). However, few investigators have used even two of these categories with the same subjects, and I know of no study involving a battery of perceptual, cognitive, personality, and learning tasks.

A number of studies not explicitly concerned with perseveration may also be relevant. For example, Thurstone's (1944) exploratory factor analysis of perceptual tasks points to possible perseverative (lag) effects in closure and speed variables. Cognitive variables have been studied extensively in a variety of contexts including rigidity and reasoning factors. As tests of perseverative tendencies many of these present problems since they rely heavily on previous learning and are often more directly measures of intelligence than perseveration. McNemar (1955) showed that many of these tests which have been used in studies of 'p' relate to reasoning ability. Guilford, more than any other single psychologist in the last few decades, has tackled the problem of the "structure of intellect" (1959) in a way that permits rational, empirical analysis. Both his tests and his conceptual framework (especially, the convergent and divergent production distinction) have had a strong impact on this research.

The present study is a search for the dimensions of trace persistence as manifested in a variety of memory, perceptual, and cognitive variables as well as in self-descriptions. It would seem that in the light of recent results in the animal literature, in neurophysiology, and in experimental psychology too it may be time to look again at the possibility that perseverative tendencies are "stable, relatively enduring components of personality organization" that may be "invoked to account for recurrent similarities and consistencies in behavior over time and over situations" (to quote Messick's definition of personality structure, 1961, p. 12). If such stable dimensions can be found, it may help the student to find ways of thinking and learning that, by enhancing his special assets and compensating for his cognitive liabilities, may permit him to make the fullest and most effective use of his unique potential.

CHAPTER II

Methods

Subjects - In the fall, 1962, 93 female Ss, all students in the introductory psychology courses at the University of Michigan, participated in a series of experiments which were individually administered. All Ss were either freshmen or sophomores. All had indicated willingness to participate for pay in further research beyond their participation in the three hours required of all students in the course. The experiments were primarily involved with the interaction of arousal (as measured by skin resistance) and the course of the memory trace. The tasks dealt with memory for form, color, words, and kinesthetic judgment. In addition, the variety of paper and pencil tasks pertinent to the present study were administered.

In spring, 1964, an attempt was made to retest all of the original sample on a variety of individual difference tests. Data were obtained for 56 women but only 44 of these were used in the analyses to be presented. The remaining 12 Ss were inadvertently administered a different group of tests and under sufficiently different circumstances that it was decided to exclude them from the analyses. Of the subjects who were not included in the retest, eleven were too busy, were unwilling, or had conflicts which made it impossible to test them and the remaining 26 were not in attendance at the University during that semester.

An additional group of 28 male Ss were given the same tasks as the 44 female subjects. These men were part of the introductory psychology subject pool and were therefore not paid for their participation.

Tests and measures - These can be divided into test scores, self-report inventories, perceptual, cognitive and memory variables, and skin resistance measures. They need further be broken down into those which were part of the 1962 testing and the ones that were used in 1964.

"Test scores" is a slightly misleading name for Grade Point Average (GPA), Scholastic Aptitude Test scores on the Verbal and Mathematical parts (SAT-verbal and SAT-math), and three scales from Fricke's Opinion, Attitude, and Interest Survey (OAIS). These three scales are the "academic promise scales" -- Achiever Personality, Intellectual Quality, and Creative Personality. Fricke (1963) describes the Achiever Personality scale as measuring "personality attributes associated with the traditional criterion of academic success, grades." The "Intellectual Quality scale was designed to provide scores which correlate highly with scores from ability tests and differs from the Achiever Personality in this respect." And the Creative Personality scale is a measure of "imagination and originality in thinking ... and capacity for reorganizing ideas" (p. 3). In all cases the OAIS and SAT tests were taken on or before admission to the University. The GPA generally included the first year or two of college depending on whether the subject was a freshman or sophomore at the time of first testing.

For the entire original (female) sample, a variety of skin resistance measures had been obtained from the concurrent recording made during the experiment. Zinc electrodes of the Lykken (1959) type and a wide band potentiometric recording system (Kaplan & Hobart, 1964) were used. These were scored for skin resistance level, pattern, and change in level as a function of the task.

The self-report inventories included a Questionnaire and Adjective Rating Form. Both these were administered to the males and the females first took the Questionnaire in 1962 and again in 1964 when they also took the Adjective Rating Form. The Questionnaire (Form C) included 23 items in 1962 and had two additional items for the males and for the 1964 tests. Three of the items were originally used by Weisgerber (1951) who used the six-choice rating procedure ("never" to "almost always") we adopted for this questionnaire. Six items were adapted from the Guilford-Zimmerman Temperament Survey and two items are part of the California Personality Inventory though both these tests use a different response format. The remaining items were developed by S. Kaplan and myself and the test has been administered to more than 350 students prior to the samples included here. The items were chosen to cover such dimensions as perseveration, energy, venturesomeness, and divergent thinking. (Throughout this paper, numbers preceded by "Q" designate item numbers on this Questionnaire.)

The Adjective Rating Form consists of 46 adjectives which were selected from Gough's Adjective Check List. However, unlike Gough's binary response format, S circled the number from 1 to 6 representing how characteristic that adjective is of himself. (It should be noted that while the Adjective Rating Form uses a scale going from 1= very characteristic to 6= very uncharacteristic, the results are reported as if the scale were reversed so that they are in keeping with the sense of the adjective. Both self-report inventories are included in Appendix A.

The following perceptual, cognitive, and learning tasks were included only in the 1962 administration: Generation, WCEN, Necker Cube, Inverted Alphabet, and Embedded Figures Test (EFT). In the group-administered 1964 sessions and for the male sample, the following tasks were included: Necker Cube, Concealed Figures, Identical Forms, Gestalt Completion, Mutilated Words, Time Estimation, Word Fluency, Brick Uses, Organization Names, Kurdish-English paired associates, Word-Number paired associates, Digit Span, and an Estimation Questionnaire. All of these tasks are described in detail in Appendix B.

The 1964 test battery was administered in the following order: Estimation Questionnaire, Kurdish-English, Necker (regular), Word-Number, Brick Uses, Word Fluency, Digit Span, Organization Names, Identical Forms, Gestalt Completion, Concealed Figures, Mutilated Words, Questionnaire Form C and Adjective Rating Form, Necker (slow), Concealed Figures Sequential, Time Estimation, Kurdish-English long-term recall and recognition, Word-Number long-term recall, and Necker (fast).

Data Analyses - Two basic methods of analysis were used in the analysis of the data: inspection of correlations and nonmetric factor analysis.

All data were initially punched on IBM cards and intercorrelation matrices were obtained on the IBM-7090. The resulting matrices, with 155 variables, were of staggering proportions. These matrices proved useful only for inspection of relationships among a group of "like" variables such as the intra-correlations of the skin resistance measures, or of the "test scores", or of the various measures that were used for any one variable (number correct vs. per cent correct, for example). Since the nonmetric factor analysis was possible on only a sub-sample of the variables at any one time, this procedure was helpful in selecting variables.

Graphic analysis of significant correlations (significance defined as two or more standard errors from the null hypothesis of zero correlation) was attempted. This procedure involves pictorial representation of strongly related variables and makes it possible to find "clusters" of measures that are strongly interrelated. Such clusters correspond fairly well to factors. However, this technique is extremely time-consuming and seriously limited in the number of variables that can be examined at one time. It is also limited to highly inter-related items although by using a different criterion for clustering a much more stable structure might be found.

The Guttman-Lingoes Smallest Space Analysis III (SSA-III) was found to be an excellent tool for data reduction. Unlike the more usual factor-analytic techniques, this "nonmetric factor analysis" concerns itself with the relationships among correlations by using a ranking procedure rather than the actual magnitudes. This leads to more stable results since rank-order changes far less than the magnitude of a correlation as different samples are used. Lingoes (1966a, 1966b) describes the mathematical features of this technique as well as similarities and differences with respect to linear factor analysis. The program is limited to 70 variables and is perhaps more useful when fewer variables are used, both because of the amount of machine time needed and because of the number of ensuing dimensions.

Several sets of 70 variables were constituted for SSA-III solutions. Of course many similarities in the resulting dimensions were found when the variables were basically similar. However, as in any factor-analytic study the choice of variables is not to be taken lightly. If, for example, the variables include several memory measures (from Kurdish-English and Word-Number), these will likely load together on one dimension with no other variable loading on the same dimension. Thus a dimension representing specific task variance is likely to result from an over-representation of a particular type of task. On the other hand, in other cases the variance represented by a particular dimension is widely distributed across a number of different measures. In such cases, choosing a small subset of these measures as "marker variables" for the next analysis can lead to the disappearance of the dimension in question. This suggests that a major part of the variance that originally defined a dimension may be necessary to preserve the dimension in future analyses.

The final printed output of the SSA-III, the normalized varimax rotation, includes the loading of each variable on each dimension. In the results discussed here, only loadings greater than .35 were considered. A variable may of course have loadings of this magnitude on more than one dimension. The largest loading was considered "primary," and all others are termed "secondary" and are indicated by parentheses.

CHAPTER III

Dimensional Analyses

The analyses of these data have been divided into several sections. Appendix C involves a discussion of alternate measures that were used for one variable or group of variables and a brief section on sex differences. These findings are included primarily as reference material and do not bear on the major findings of the study. Chapter V will deal with results of the reliability analyses -- the variables that were used for the female sample both in 1962 and 1964. The results presented in this chapter are based on the Guttman-Lingoes Smallest Space Analysis (SSA-III) solutions. Nine dimensions will be presented here. The next chapter is devoted to a discussion of these dimensions with respect to the theoretical position that motivated this research.

Appendices D and E indicate the dimensions resulting from the SSA-III nonmetric factor analyses for the female and male samples, respectively. The variables used in the initial SSAs consisted of all the Questionnaire Form C items (except #25 for the males), thirty-one of the Adjective Rating Form items, the Estimation Questionnaire, three memory scores (short-term recall for Word-Number, and short- and long-term recall for Kurdish-English), and a variety of perceptual and cognitive tests: Identical Forms, Gestalt Completion, Concealed Figures (number correct), Mutilated Words, Necker fluctuations, Brick Uses (number of shifts in categories), Word Fluency, Digit Span (longest span correct), Organization Names, and mean per cent error on Time Estimation. For the male sample, SAT-math was also included.

(For both computations, the 70-variables analyses were set for 20 dimensions with five iterations for the male sample and eight iterations for the female sample. The coefficient of alienation was approximately .08 for the male sample and .18 for the female sample. A loading of .35 or greater was used as the cut-off in evaluating the relationship of a variable to a dimension.)

Rather than to examine each of the dimensions indicated in Appendices D and E, the discussion in this chapter will deal with those dimensions which repeatedly result from these SSAs. (That is, even when somewhat different combinations of 70 variables were used.) In most cases, the male and female samples led to very similar dimensions and these will therefore be discussed together. It should be pointed out that as with any kind of factor naming, these "code" names should be taken as suggestive and for whatever mnemonic value they may have. Throughout this chapter, dimensions numbers refer to the listings in the appendices.

Methodical and Perseverative - These two dimensions consist only of self-descriptive items. The relevant items are summarized in Table 1.

Table 1 - Items Relevant to
Methodical and Perseverative Dimensions

	Male I	Female II	Male V	Female VI
Organized	x	x		
Methodical	x	x		
Painstaking	x	x		
Q15: Systematic problem-solving	(x)	x		
Cautious	x			
Non-Complaining	x			
Deliberate	x			
Non-Absentminded or forgetful	x			
Q1: Difficult to put down started project	x			x
Thorough		x		
Persistent		x		
Persevering		x	x	
Q23: Problem comes back to mind		x	x	
Q8: Prefer one task at a time			x	x
Q9: Uncomfortable about things left up in the air			x	x
Non-Preoccupied			x	
Q24: Dislike change of plans				x

The picture that emerges is suggestive of a difference between a tendency to be methodical and a tendency to be perseverative. A methodical person (Dimensions I for the men and II for the women) would be one who is strongly oriented toward working on the task at hand; he would be goal-directed and persevering, and as indicated by these descriptions, he would be organized and painstaking about his efforts. While a methodical person may be perseverative as well, a person can be perseverative without being deliberate and painstaking. For to be perseverative implies a recursive process, a cognitive continuation of a ceased activity, and hence a preference for doing fewer things at a time so that they might be completely terminated before new projects are begun (Dimensions V for the men and VI for the women).

The original title of this project was "Individual differences in perseverative tendencies" and this was changed (at the suggestion of the Office of Education) to "Individual differences in student tendencies to persevere." We have here indication that both titles were appropriate, since the methodical dimension could also be called "persevering."

Imaginative - The male and female analyses show remarkable agreement in the constellation of variables here called "Imaginative." In both Dimension II (Appendix E) and Dimension IV (Appendix D) these self-descriptive items loaded: Imaginative, Original, Resourceful, Ingenious, and (Q21) "Readily think of new ideas." In addition, for the women, the similar questionnaire item (Q6) "New ideas when returning to a problem" loaded on this dimension, and for the men, related characteristics were Wide interests and being Humorous. These are all suggestive of creative potential. The fact that "Humorous" loaded with these items for the men corroborates the results Getzel and Jackson (1962) have found in their studies of creativity and intelligence.

Venturesome - Dimension III for the female sample deals with such characteristics as being Adventurous and Daring, Needing variety and change (Q2), being curious (Q16), craving excitement (20), and looking forward to new experiences (Q14). These people report themselves to be fun-loving and seeking adventure. The parallel dimension for the men (Dimension VIII) indicates that people who say they crave excitement, look forward to new experiences, and are adventurous, are also more likely to describe themselves as bored (Q18). Both for the men and women there is a suggestion that "Difficulty learning language vocabulary" (Q5) is also characteristic of these venturesome people.

In several analyses it was found that Q16: "In general, how curious do you feel you are" was interpreted differently by men and women. Women who say they are curious are the ones who crave excitement and seek adventure. One would imagine that they would enjoy traveling and are curious to see and experience new things. For men, by contrast, "needing variety and change" (Q2) goes contrary to being curious (Dimension XVI) and these items did not load with the Venturesome cluster. In a future study it may be interesting to determine if men interpret the "curious" item in a more conceptual way (as opposed to the more perceptual interpretation by the women) -- to be curious would involve exploration of ideas and concepts. If this is the case, it is not surprising that this item seems unrelated to this dimension.

Energetic - For the men, Dimension VII, and for the women, Dimension I, share items related to self-descriptions of Energetic, Active, "Feel full of energy" (Q7), and being "on the go" (Q3). Men who describe themselves as energetic also find they think of new ideas when they return to a problem (Q6), while for the women, related variables are having no objections to having many different tasks to look after (Q17), enjoying to adapt themselves to new and unusual situations (Q25, which was not included in the male matrix), and a greater production of Organization Names.

There is a suggestion in the Energetic dimension of a kinship with the Venturesome dimension but in this dimension it seems more channeled in the direction of work than adventure. (This will be discussed further in the next chapter.)

Attention - Dimension IV in the male SSA consists of several questionnaire items: bothered by useless thoughts (Q12), difficulty with attention to detail (Q19), dislike change of plans (Q24), restless when listening to lectures (Q11), difficultywith long stretches of concentration (Q4), and the adjective "Distractable." This cluster of items also loaded with high Necker reversal scores. One gets the picture of a relatively distractable person, who cannot stay long at a task, whose attention span must be short. In the case of Necker fluctuations, this may mean that the attention to each figure breaks off rapidly leading to a high reversal rate.

For the women these variables divided into two separate dimensions. Dimension VII showed a relationship between Necker reversals, (Q12) bothered by useless thoughts, and (Q13) disturbed when interrupted -- indicating again a possible relationship between Necker reversal rate and a tendency to be distracted readily. (Note that the adjective "Distractable" loaded on a different and seemingly unrelated dimension, VIII, suggesting that perhaps this adjective is interpreted differently my men and women.)

Dimension IX takes two of the items from the Attention cluster described for the men, to form a constellation consisting of (Q19) difficulty with attention to detail, (Q4) difficulty with long stretches of concentration, (Q22) lack of drive, (Q17) preference for fewer responsibilities, and the self-characterization of non-Humorous. Here is a group of items showing a preference for less work, fewer demands, non-attention, or perhaps something like low ego strength.

Test scores - Since the SSAs discussed here and presented in the Appendices included no test scores (GPA, SAT, and OAIS) except for SAT-math for the men, other SSAs were carried out which included these scores as well as the perceptual and cognitive measures but fewer Questionnaire and adjective items. In the following discussion, reference to test scores involves these solutions.

For the women, SAT verbal and math loaded together on one dimension. Fricke's OAIS 5 - Intellectual Quality and GPA had secondary loadings on the same dimension. Interestingly, self-description of Intelligent was the other variable here.

The primary loading for GPA was with memory for paired associates, Generation and Brick Uses. The primary loading for OAIS 4 - Achiever Personality was in the opposite direction than mean per cent error of Time Estimation and Gestalt Completion. And OAIS 5 and 6, Intellectual and Creativity, both loaded negatively with Mutilated Words and the adjective "Inhibited."

The picture for the women then is that these academic performance variables tend to form one dimension, that ability to memorize is related to grade point average and that the OAIS measures did not load as would have been expected from Fricke's manual.

For the men, by contrast, there was no single dimension with loadings of more than one of these variables, except that OAIS 6, Creative Personality, loaded with the adjective "Daring" and OAIS 4, Achiever Personality, loaded in the opposite direction. SAT verbal loaded with paired associate memory; SAT math loaded with perceptual and cognitive measures (as in Dimension X, Appendix E which will be discussed below); and OAIS 5, Intellectual Quality, loaded with Digit Span. Another dimension, revealed that men with low GPA, had more difficulty learning language vocabulary (Q5), considered themselves Alert, Adverturous, Craving excitement (Q20), and Humorous. Their Digit Span (secondary loading) was also poor. So, being Venturesome is not conducive to a high grade point average!

Although there is no general ability factor here, it would seem that GPA and SAT verbal and math loaded in explicable fashion, but the OAIS measures did not materially contribute to one's understanding of these individual difference dimensions.

Memory - The two dimensions dealing with memory for paired associate items (IX for the men and V for the women) had virtually no other variables. In the SSAs which included test scores, it was found that for the men SAT verbal loaded with memory for paired associates (and incidentally, Word-Number recall was not isolated as in Dimension XX), and for the women, GPA was related to paired-associate memory as were Generation (administered in 1962) and to some degree, Brick Uses.

Digit Span also involves memory. For both men (Dimension XII) and for the women (in the other SSA), this variable loaded with Q5; Difficulty learning language vocabulary, in opposite directions, of course. For the men, Digit Span loaded principally with OAIS 5 - Intellectual and secondarily with GPA on a Venturesome dimension (as mentioned above).

These findings support the notion that the paired associate memory tasks involved different abilities from Digit Span, and that memory, as Guilford suggests, is not a unitary trait.

Perception-cognition - Here the male and female patterns are decidedly different.

For the women, Time Estimation (mean per cent error) and Gestalt Completion loaded together (Dimension XIII). Mutilated Words, a task seemingly similar to Gestalt Completion, did not load on that dimension but instead on Dimension XIX together with Q5; difficulty learning language vocabulary. Identical Forms and Concealed Figures went together to some degree for the women (Dimension VIII) with Distractable and Careless going in the opposite direction. Organization Names loaded on the Energetic dimension, and people with low number of Brick Uses said they were Cautious. The picture for the women with respect to these variables is diffuse. In the SSA found in Appendix D, these variables loaded on seven different dimensions (using primary loadings only and without any test score variables included)!

For the men, the perceptual-cognitive variables loaded on two dimensions, VI and X. (Time estimation formed a unique dimension.) These two dimensions seem to be related to each other inasmuch as items from one dimension loaded secondarily on the other. In the SSA which included test scores less overlap was found.

The resemblance between these two dimensions and Thurstone's (1944) Factors A and E, respectively, is striking indeed. The variables with primary loadings on these dimensions are reproduced below:

Dimension VI	Dimension X
Mutilated Words	SAT-math
Gestalt Completion	Concealed Figures
Identical Forms	Brick Uses - shifts
Word Fluency	Organization Names
Q17: Prefer not to have many different tasks (loads negatively)	
Impatient	

Thurstone's Factor A, speed and strength of closure, represents "the ability to form a perceptual closure against some distraction" (p. 101). Gestalt Completion and Mutilated Words, and a task much like Identical Forms loaded on Thurstone's factor as well. These tasks share the characteristic that one readily sees them or one does not, one is verbally fluent or one is not. In other words, little judgment is required, the tasks do not require testing of many hypothese for their solution. Though Necker fits the description to some extent, it is interesting that in both Thurstone's work and in the present study Necker did not load on this dimension.

Thurstone's Factor E, flexibility of closure, requires "the ability to shake off one set in order to take a new one... It implies flexibility in manipulating several more or less irrelevant or conflicting gestalts ... One might wonder whether this factor represents one important aspect of intelligence" (p. 111). Concealed Figures loaded on this dimension for Thurstone too, as did a reasoning test. SAT-math, Organization Names, and Brick Uses are certainly excellent candidates for his description of this Flexibility of Closure factor. It is also not surprising that these two dimensions show much overlap since speed would certainly facilitate such flexibility.

(It is interesting to note that these dimensions do not correspond to expectations based on Guilford's "three faces." These results cut across each of these faces with "figural," "symbolic," and "semantic" content represented, as well as a variety of products. As for operations, Guilford would consider Mutilated Words and Gestalt Completion to fall under "cognition," while Word Fluency would involve "divergent production" in his conceptualization. Likewise, for Dimension X, while Brick Uses and Organization Names are considered "Divergent," Concealed Figures is an example of "Convergent" for

Guilford. These results point to the possibility of strong interrelations among his cells, and to the fact that many tasks involve more aspects of intellect along a single dimension of his cube than his pigeon-holing permits.)

CHAPTER IV

The Facets of Trace Activity: An Integration

The results of the dimensional analyses suggest two important conclusions. First, it is useful to study individual differences from the perspective of a theory of trace activity. Second, "perseveration" is not a unidimensional process. Most of the dimensions obtained can be interpreted in terms of parameters of trace activity. At the same time, they are distinguishable. It seems inappropriate to call them all "perseveration" not only because they are different but also because they are independent. A person's score on one dimension provides no information about his score on another one.

Thus while these dimensions may all be concerned with a single underlying process, their relation to or effect on this process must be distinct. There appear to be three ways in which these dimensions can be quite clearly distinguished: the time base, the source of interference or competition, and the relation to trace activity. In other words, some of these dimensions concern processes that are measured in milliseconds, some in seconds and some in minutes or even hours. Further, some are primarily oriented to the possibility of internal distraction, the effect of some traces on other traces, while others are directed toward the influence of external stimuli on ongoing trace activity. And finally, different ones of these dimensions are concerned with the formation, the persistence and the recurrence of the neural trace. Before pursuing this analysis in greater detail, it may be useful to identify the dimensions for which this analysis is <u>not</u> appropriate.

Of the nine dimensions discussed in the previous chapter, three deal with aspects of the organism more global than trace persistence. Of these, Venturesome and Energetic are closely related and the third, paired-associate Memory, stands apart for a number of reasons.

Both <u>Venturesome</u> and <u>Energetic</u> are pervasive characteristics of an individual, even determinants of a life style. In a sense, the essential difference between them is that one is negative and one positive. It seems clear from the items loading on the Venturesome dimension that this is a restless characteristic, a perceived lack of excitement, a hunger for experience. The Engergetic dimension, by contrast, emphasizes a surplus of resources, rather than activity motivated by a deficit.

In terms of a neuropsychological theory, the Energetic dimension is closely related to the arousal concept as described by Hebb (1955) in his "Drives and the CNS." The Venturesome dimension

could be interpreted as a pervasive attenuation of stimulus input. Something of this sort was presumably intended by Petrie et al. (1960, 1963) in their proposal of the "reducer-augmenter" dimension. The "reducers" are seen as somehow reducing the influence of external stimulation. They are described as more tolerant of pain and less tolerant of sensory deprivation than the subjects at the other end of the continuum. In terms of the neuropsychological theory underlying the present study, the hunger for experience characteristic of the Venturesome dimension is related to a high level of transmitter hydrolizer. This substance (ChE in the case of cholinergic transmission) destroys the transmitter substance and thus presumably dampens trace activity. For this reason, greater stimulation would be necessary to maintain a normal level of neural activity.

The third of the more global dimensions, paired-associate memory, stands apart for both theoretical and methodological reasons. In terms of the perseverative consolidation hypothesis, the more the activity of the circuit in question, the greater the connection strength. This might result from intense activity over a fairly short period, or a lower level of activity sustained for a longer period of time, or some point in between. Since memory is crucial for the successful adaptation of the organism, it seems reasonable that this necessary end result might be achieved in more than one way.

Besides such theoretical possibility of compensatory mechanisms, there is the even more serious complication that is essentially methodological. Both paired-associate memory tasks used here, after Clark, are of the "self study" variety. That is, they are not experimenter-paced as in the controlled verbal learning situation; rather, they are essentially self-paced. The subject does have a limited amount of time to learn the items, but within this time he is free to pursue his own strategy. He may learn a few items very well or try to cover the entire list as best he can. He may concentrate on both stimulus and response items or concentrate primarily on the response items on the assumption that the stimulus item will be provided. If these strategy differences are a major factor in the performance differences between subjects on these tasks, then this dimension represents not basic memory processes, but some mixture of this and much more molar factors. Presumably attitude, past experience, etc. play important roles here. Further study of this problem is clearly called for.

The six dimensions that appear to represent different facets of trace activity are Strength of Closure, Flexibility of Closure, Imaginative, Attention, Methodical, and Perseverative. Their similarities and differences can perhaps best be discussed in terms of the three categories introduced above, that is, in terms of the time base, the source of competition, and the role each plays in trace activity. The classification of each of these dimensions is summarized in Table 2. There follows a discussion of how these decisions were reached for each dimension in turn.

Table 2 - Summary of Classification of Dimensions

Relation to Trace Activity	Dimension	Time Base	Source of Competition
Trace formation	Strength of Closure	Very Short	External
	Flexibility of Closure	Short	Internal
Trace duration	Imaginative	Variable	Internal
	Attention	Variable	Nonspecific
	Methodical	Long	External
Trace recurrence	Perseverative	Long	Internal

There are two dimensions concerned with trace formation. Strength of Closure deals with the development of a single trace; Flexibility of Closure involves the development of two or more parallel traces. Since trace formation can occur in a matter of milliseconds, these dimensions clearly apply to a short time base. The critical difference between these dimensions is in the source of competition. The competition is clearly external in the case of the Strength of Closure dimension; Thurstone's definition concerns "the ability to form a perceptual closure against some distraction" (1944, p. 101). Likewise the internal character of the competition in the case of Flexibility of Closure is also explicit in the original definition. Thurstone emphasizes "the ability to shake off one set to take a new one. It implies flexibility in manipulating several more or less irrelevant or conflicting gestalts" (p. 111). Note here the potentially interfering role of a set or a gestalt, that is, a neural trace as opposed to an external stimulus.

Three dimensions are concerned directly with trace duration; that is, with the span of activity of any particular trace. It is important not to be misled by the dimension names in applying this interpretation. The influence of the Attention and Methodical dimensions is toward trace longevity, while the Imaginative dimension implies trace brevity. In other words, for these three dimensions to be parallel with respect to trace duration, the Imaginative dimension would have to be reversed (i.e., to "Unimaginative").

Of these three dimensions, only one has a specifiable time base. The Methodical dimension clearly involves relatively long periods of time. A person is not "organized" and"methodical" in milliseconds or seconds, but in minutes and even hours. The Attention and Imagination dimensions, by contrast, apply to a considerable range of time. Concentration on the one hand, and problem-solving on the other, apply to seconds as well as minutes and hours.

These dimensions form an interesting pattern with respect to the source of competition. The Imaginative dimension can be viewed as the faciliation of internal competition. In other words, readily thinking of new ideas requires a succession of different ideas, a sequence of internal interruptions. The Methodical dimension, by contrast, seems to deal with the prevention of external competition. The organized, painstaking person is one who keeps the many aspects of the problem under control. The thrust of the organizing here seems to be external or problem-centered, rather than internal.

The third member of the triad, Attention, seems the nearest to a pure case of trace duration. That is, an individual scoring low on this dimension tends to have traces that terminate relatively quickly. What takes their place is indeterminant -- competition could be either internal or external.

The Perseverative dimension involves trace recurrence. That is, a trace which has ceased to be active more or less spontaneously becomes active again. This is a long time span phenomenon, and obviously one that involves internal competition; that is, the competition of prior thoughts with present trace activity.

The preceding interpretation is not intended to be either final or complete. It has two primary purposes. First, it indicates that the dimensions obtained are interrelated in terms of the basic mechanism, and still meaningfully distinguishable. Second, it provides an illustration of the kind of analysis fostered by a neuropsychological theory concerned with trace activity. In this latter purpose it is intended to be only suggestive.

From the point of view of a rigorous neural model, this is only a very sketchy and preliminary attack on the problem. A full treatment of the dimensions in these terms requires further development of what is already a fairly complicated model (Kaplan, 1962; 1964). The following hypotheses may provide an indication of the kind of development required.

1. The Strength of Closure dimension is based on rapid build-up of short-term connection strength. (Short-term connection strength is a temporary increase in the amount of transmitter substance released by a given endfoot each time it fires. The formation of a trace is based on an increment in short-term connection strength. This is central here because Strength of Closure is assumed to be a reflection of rapid trace formation.)

2. The Flexibility of Closure dimension is based on the proportion of inhibitory units in the cortex. (Inhibitory units influence the amount of activity in the cortex at any one time. To the extent that this dimension involves multiple sets, there must be proportionately low enough inhibition to allow more activity, that is more traces, at a given point in time.)

3. The Imaginative dimension is based on a high level of inhibitory transmitter substance. (This would permit some new trace to block other influences, thus freeing the system for the new trace.)

4. The Attention dimension is based on a high level of excitatory transmitter in the endfoot of the neuron. (This permits sustained trace activity until the endfoot transmitter is depleted.)

5. The Methodical dimension is based on a slow neural fatigue buildup. (Trace activity is generally terminated by neural fatigue. A slow fatigue buildup would permit unhurried attention to each detail, in a systematic, careful fashion. This involves the persistence of a trace, as opposed to the recurrence of a trace as in #6 below.)

6. The Perseverative dimension is based on rapid recovery from neural fatigue. (Neural fatigue is conceptualized as a temporary deficit in the cell's resources due to intense activity. Rapid recovery would permit the trace to be reactivated before the short-term connection strength has time to dissipate.)

CHAPTER V

Test-Retest Analyses

The forty-four women subjects who participated in the large battery of tests in 1964 had been part of a large ~~sample~~ sample which was involved in a series of studies in 1962. Included in the 1962 session were the Questionnaire Form C which the Ss completed again in 1964, and Necker Cube which was repeated later, as well as WCEN and Embedded Figures Test which were considered to be similar to tasks included at the later time. These variables then form the subject of this chapter.

The intention was to see if these are reliable measures -- if Ss will score similarly on them one and a half years apart. As indicated in Appendix C, the earlier Necker administration loaded with the later one on the same dimension. In fact, the Necker score for the first 30-second period in 1962 and the comparable period in 1964 correlated .71 (even though the task was individually administered the first time and group administered the later time). This finding supports the contention that Necker involves a more underlying property of trace function and is a relatively stable individual difference measure.

Embedded Figures Test is a relative of Concealed Figures. The EFT is, however, a less sensitive measure. The S is told the figure is embedded in two of four pictures and is permitted a full minute to explore each of the five problems. For the sequential form of Concealed Figures the experimenter again paces the task, but this time only five seconds were allotted to view the test figure and only ten seconds to pick the correct answer. Despite this considerable difference in the time permitted for the problem and that Ss were forced to use a memory strategy for the sequential Concealed Figures, these two measures correlated .44 with each other. The regular Concealed Figures test is a speed test in that five minutes were allowed for 21 problems and S was told that the answer may be in one or more of the four choices. There is the possibility here for speed and accuracy to work against each other; both are necessary to get any correct answers. For a high per cent correct score, however, accuracy is the important dimension. It is this measure, per cent correct on Concealed Figures, that correlated (.41) with EFT, where accuracy also has a better chance to operate. Though these relationships of EFT and Concealed Figures are low they are significant and are all the more striking considering the noted differences in the tasks and the many months which elapsed between the two administrations.

WCEN, involving writing sentences with the initial letters specified, was thought to parallel the Organization Names task used in the 1964 battery. The latter task also prescribes initials that must be used in the given order, two minutes were allotted for each task,

and four letters were used in each case. None of the measures used for the two tasks correlated significantly with each other. This may be due to non-reliability of the measures, to the sample involved, or to differences in the tasks themselves. At this point one can only guess at the reasons. In the future, it might prove profitable to administer both tasks during the same testing session. In terms of Thurstone's two closure factors discussed in a previous chapter, it would seem that WCEN is a somewhat simpler task since almost any words can be used provided they begin with the specified letters, while for Organization Names there are more severe constraints and therefore more sets must be held. However, it was also found that the female data yielded a rather scattered picture with respect to the perceptual and cognitive domain, suggesting the need for replication.

To evaluate the reliability of the Questionnaire, an SSA-III was conducted which consisted of all the Questionnaire items from the 1962 and 1964 administrations as well as 22 items from the Adjective Rating Form. The resulting dimensions are presented in Appendix F which also provides a scoreboard for how the parallel items fared. For example, in the first three dimensions, parallel items from 1962 and 1964 loaded on the same dimensions with hardly an exception. In the cases of some other dimensions, such as IV and V, there are many more "exceptions." While these might be considered instances of "non-reliability," there is also the possibility that they indicate psychologically meaningful changes in the relevant dimensions which occur during the dynamic first years of college. These suggest the need for further study directed specifically at tracing the evolution of study habits and strategies, of seriousness of intention and need for adventure, in the course of the college years.

Dimension I corresponds to the Methodical-Perseverative dimensions discussed in Chapter III. It overlaps with both Dimensions II and VI (Appendix D) and shows that the two dimensions may be closely related.

Dimension II duplicates the Imaginative dimension. Dimension III corresponds to the Venturesome cluster found in the main analysis.

Dimension IV closely resembles Dimension IX (Appendix D) which was discussed previously in terms of lack of ego strength or distraction, or poor attention span. However, two of the items which loaded only in 1962 were not included in the previous result either. There is a hint here perhaps of a changed perception: as a freshman one might find it hard to put down a started project, but by the time one is a junior one finds one does it all the time anyway. But this is post hoc, of course.

Dimension V corresponds to the Energetic dimension, but the 1962 Questionnaire responses do not form this pattern.

Dimensions VI and VII deal primarily with material which was only included in 1964 and therefore do not bear on the reliability issue discussed here.

In Dimension VIII there is the suggestion that people who characterized themselves as being "on the go" (Q3) and "craving excitement" (Q20) early in their college careers, later on characterized themselves as "distractable." It is not hard to see a relationship between these, but the fact that the corresponding Questionnaire items from 1964 did not load with the ones from 1962, suggests a changed pattern in the responses to these items.

The remainder of the dimensions are meager, generally involving only two primary-loading variables.

It should perhaps be pointed out that the test-retest correlations for each Questionnaire item ranged between .21 and .57, averaging .41. (Items #7, 10, 13, and 19 did not correlate significantly.) It could be argued that for reliability purposes, all of these are low correlations, but the SSA results would suggest a more stable structure than this pattern would lead one to expect.

Analysis of subject-reliability rather than item-reliability yielded striking results. (In other words, rather than examining the test-retest coefficients for each Questionnaire item, this analysis involved computation of test-retest coefficients for the 23 Questionnaire items for each subject.) These correlations averaged .66, with all but five of the 44 Ss having test-retest correlations equal or greater than .50. One-fourth of the coefficients were greater than .80. Since all Questionnaire items are involved in this analysis, rather than each one separately, and since the results held across the majority of the sample, these findings strongly support the contention that the Questionnaire was consistently answered at the two occasions, separated by one and a half years. The fact that many of the items loaded similarly in the dimensional analysis, further encourages one to say that the underlying dimensions obtainable from the Questionnaire are also stable.

CHAPTER VI

Conclusions and Implications

The major conclusion of this research is clear: there are meaningful, orderly individual differences in the way students perceive and think. Further, these results were obtained not by taking the traditional personality-motivation approach to individual differences, but by taking a rather untraditional point of view based on a neuropsychological theory.

There is one very general implication of this research. Findings of considerable relevance for educational practice can be obtained through application of a highly molecular theory and in a context of basic research. The many more specific implications can perhaps best be divided into three categories, those dealing with methodology, those concerning future research, and those having direct application to practical issues.

The essential methodological point is quite simple. There are important dimensions of individual differences worthy of study by those interested in such things and worthy of respect from those who are not. For the most part, the literature on individual differences in perception and cognition is dismal. Confusion and contradiction abound. There is some reason to believe that the beginning described here offers a hopeful new approach. Likewise the Guttman-Lingoes Smallest Space Analysis is to be recommended over many currently popular procedures. Those scientists not interested in individual differences are asked to remember that these factors will presumably operate nonetheless. Since small samples may not have an equal representation of all these dimensions, spurious results and apparent failure to obtain results could occur quite apart from the intended manipulations. Auxiliary use of individual difference assessment could provide essential information when confronting otherwise not readily interpretable data. In other words, prior measurement may serve as inexpensive insurance.

The implications for future research are many and varied. There are perhaps four main areas where clearly specifiable studies could contribute to the practical impact of the results obtained in this project. First, characteristic patterns of dimensions should be explored. All of the subjects in this study were relatively capable students -- they could hardly have gained admission to a rather selective university were they not. Nevertheless they differ considerably on the dimensions discussed in previous chapters -- necessarily, since without subject variability there would have been no dimensions in the sample to discuss. It may be that only certain patterns of dimensions appear in our sample. In other words, there may be compensatory effects between dimensions; for each dimension there may be one or more other dimensions that offset its effects, at least in part. In addition to looking at characteristic patterns in the sample, it might be valuable to determine if certain patterns of dimensions predict performance better than a single dimension does. This could add further support to the compensatory hypothesis.

A second research direction is closely related to the first: a less highly selected sample might yield additional valuable information about patterns of dimensions and performance. One would anticipate, for example, to have a wider range of patterns represented, the less highly selected the sample. The relation between pattern and performance would also be likely to be more striking in such a sample.

The third research direction involves an analysis of the role of the dimensions individually or in patterns, in tasks of practical interest and importance. This is a necessary step for the fourth and culminating research objective, the development of techniques of training individuals in the appropriate skills for counteracting difficulties or deficits arising from their particular dimensional pattern.

The practical implications of this project are necessarily limited; the further studies described above must be carried out before concrete action can be appropriately taken. Nonetheless, the direction is clear. There are individual differences in normal, bright, students in the way they think and perceive. Thus it is unlikely that the same educational procedures are appropriate for all students. Further, some and perhaps all of these dimensions appear to be very basic and conceivably even rooted in the physiology of the individual. Thus one would not approach the problem of changing these patterns lightly. Compensating for basic tendencies by teaching relevant supportive and complementary skills seems wiser and more humane than attempting basic changes which could be extremely difficult to achieve and perhaps damaging as well. Thus education might profitably take as a starting point a knowledge of and respect for the pattern of dimensions characteristic of each individual. This might not only put effort where it is needed most, but also eliminate considerable unnecessary or misdirected effort. It may be possible in this way to maximize our resources and enhance the efficiency of the educational process at the same time.

CHAPTER VII

Summary

In the light of recent results in neurophysiology, in the animal literature, and in experimental psychology, it may be time to look again at the possibility that perseverative tendencies are stable components of personality structure. This research is motivated by a neuropsychological theory which postulates that nonspecific neural activity and parameters of synaptic transmission play vital roles in modulating trace activity. Thus, individual differences in perceiving and thinking are conceptualized as reflections of these underlying processes.

The variables were selected with these considerations in mind. Unlike much previous research in personality, the present study involved a great variety of measures including memory (e.g., paired associate recall and recognition, digit span); perceptual tasks (e.g., Necker cube, Identical Forms, Concealed Figures, Gestalt Completion, Time Estimation); cognitive tasks (e.g., Word Fluency, Brick Uses, Organization Names); academic performance predictors (Grade Point Average, SAT, OAIS); and self-report inventories dealing with such things as cognitive styles and preferences, energy and curiosity.

The subjects were undergraduate students. Ninety-three women participated in the initial phase of the study; forty-four of these returned a year and a half later. Thus, for some variables, a test-retest design was used to measure reliability. In addition, twenty-eight men served as subjects for the group-administered tests.

The major mode of data analysis was the Guttman-Lingoes Smallest Space Analysis III which is a nonmetric factor analytic technique. Instead of analyzing relationships between correlations, per se, this program concerns itself with the rank-order relationships among the correlations thus yielding more stable solutions.

The major results of this study are therefore in the form of the dimensional solutions of the SSA-III. The nine dimensions which were interpreted were:

Perseverative - Implied here is a recursive process, a cognitive continuation of a ceased activity, and hence a preference for doing fewer things at a time so that they might be completely terminated before new projects are begun. This dimension most closely parallels the traditional perseveration concept.

Methodical - Goal-directed, organized efforts are characteristic here. Self-descriptions of Methodical, Painstaking, Persevering and Deliberate fall in the dimension.

Attention - Items dealing with "Difficulty with attention to detail," "Ability to concentrate," being Distractable, and rate of Necker cube reversal loaded on this dimension..

Imaginative - The constellation of items loading on this dimension included Imaginative, Original, Resourceful, Ingenious, and "Readily think of new ideas" -- all suggestive of creative potential.

Strength and speed of closure - This and the next dimension correspond strikingly to two of Thurstone's factors and his names have therefore been adopted. Both these dimensions were obtained for the men only. The perceptual and cognitive variables loading here have in common that they require little judgment, one readily perceives the picture (say, in Gestalt Completion) despite the distracting form of presentation, or one does not.

Flexibility of closure - In this Thurstonian dimension, the ability to hold several sets and "shake off" some of them in order to try others is essential. Although a certain amount of "divergent production" is involved here, the dimension does not parallel Guilford's conception of "intellect."

Paired-associate memory - The paired-associate memory variables tended to form a dimension of their own. For the men, SAT verbal and for the women, grade point average were related to this ability.

Energy and Venturesome - The former included self-characterizations of feeling "full of energy," "being on the go," and "active," all suggesting a surplus of resources. By contrast, Venturesome was the name given to the cluster of items dealing with "craving excitement," "needing variety and change," "looking forward to new experiences," and being "adventurous," all of which create the impression of a deficit of stimulation, and hunger for excitement.

Results of the test-retest variables were by and large suggestive of stability. For the 23-item Questionnaire, the subject-reliability averaged .66 and the Questionnaire items generally loaded similarly for the first and second administrations. However, it was also suggested that failure of "reliability" in the case of the Questionnaire may be an indication of meaningful changes in the habits, strategies and attitudes of college students. A future study might profitably utilize this technique to study the evolution of these characteristics.

The major conclusion reached from these results is that there are meaningful, orderly differences in the way students perceive and think. It was found that the mechanisms of neural trace activity provide a helpful framework for understanding and explaining these dimensions. In particular the role in trace activity, the time base, and the source of interference were concepts that seemed useful in relating and distinguishing the various dimensions. Hypotheses as to the relationships between these dimensions and their molecular substrates were presented, especially as an illustration of the usefulness

of a neuropsychological theory in dealing with pervasive individual differences in personality.

The results obtained in this study suggest that individual difference data provide useful information both in conjunction with other data (as auxiliary measures) and in their own right. Future research on the patterns that these dimensions form should be particularly helpful in applying these findings to educational settings. Through knowledge of such stable dimensions each student could be guided in enhancing his special assets and compensating for his particular cognitive liabilities. An enlightened and informed educational system could thus do much to aid each student in finding ways of thinking and learning that permit him to make the fullest and most effective use of his unique potential.

APPENDIX A

Self-Report Inventories

Included here are the two inventories described in the Methods chapter. For the Questionnaire, unless otherwise noted, the choices for each item were: Never, Seldom, Occasionally, Often, Very Often, Almost always, and S was instructed to "circle the most appropriate answer." The 25 items on Questionnaire (Form C) were:

1. Once you get started on something, you find it difficult to put it down until you are finished.
2. Compared with most people, you need variety and change - much more, more, somewhat more, about the same, less, much less.
3. You are the kind of person who is "on the go".
4. You find it difficult to concentrate on one thing for a long time at a stretch.
5. You have difficulty learning language vocabulary.
6. When you have laid a problem aside you find that you think of new ideas when you return to it.
7. You feel full of energy.
8. Do you prefer to do one task at a time and finish it before going on to another, rather than to have several "irons in the fire" at the same time?
9. You feel uncomfortable about things being left up in the air.
10. Do you do better by thinking straight through a problem from start to finish, rather than frequently dropping it and taking it up again later?
11. You can listen to a lecture without feeling restless.
12. You are bothered by having a useless thought come into your mind over and over.
13. In general, are you disturbed by being interrupted when you study?
14. You look forward to new experiences.
15. You find that the best way to solve a problem is to systematically think it through step by step.
16. In general, how curious do you feel you are? - extremely curious, curious, somewhat curious, not particularly curious, incurious, totally incurious.
17. Do you prefer not to have many different tasks or duties to look after?
18. You are bored.
19. You have difficulty with jobs that require attention to many details.
20. You crave excitement.
21. You readily think of new ideas.
22. You lack the drive necessary to get as much done as other people do.
23. If you have laid aside a problem, do you find that it still keeps coming back to mind?
24. I dislike to change my plans in the midst of an undertaking.
25. I do not enjoy having to adapt myself to new and unusual situations.

Adjective Rating Form

For each of the following adjectives circle the number that best expresses how well that adjective describes you. Use the following key:

1 = very characteristic of me
2 = characteristic of me
3 = somewhat characteristic of me
4 = not particularly characteristic of me
5 = not characteristic of me
6 = totally uncharacteristic of me

The subject was then presented with the following list of adjectives, each preceded with the numbers 1, 2, 3, 4, 5, 6:

absent-minded
active
adaptable
adventurous
alert
anxious
apathetic
careless
cautious
clear-thinking
cluttered
commonplace
complaining
complicated
conscientiousness
conventional
daring
deliberate
distractable
energetic
enthusiastic
forgetful
headstrong
humorous
hurried
imaginative
impatient
ingenious
inhibited
intelligent
lazy
methodical
organized
original
painstaking
persevering
persistent
preoccupied
relaxed
reliable
restless
resourceful
stubborn
tense
thorough
wide-interests

Note: In the Appendixes which follow, the results are reported as if the scale for the Adjective Rating Form were reversed, going from "very uncharacteristic" to "very characteristic." Likewise, for Questions 2 and 16 of the Questionnaire, the results are reported as if the response choices were in opposite order.

APPENDIX B

Perceptual, Cognitive and Learning Tasks

From the 1962 Battery:

Generation: The S is given two minutes in which to produce as many words as possible using the letters in the word "generation." The words must have at least three letters and proper names are not permissible. The score is the number of such words produced.

WCEN: Guilford (1959) describes this as a measure of "expressional fluency." In two minutes S is to compose sentences of four words each where the successive words start with the letters W, C, E, and N, always in that order. These were scored for the number of sentences produced, the number of different sentences (no more than one of the words may be used in a previous sentence), and for the ratio of the number of different words divided by the number of sentences. This last number is a kind of originality quotient with numbers ranging from about 1.5 to 4.0

Necker Cube: The S stares at a Necker Cube and records every 30 seconds (when the signal is given) how many times the figure reversed. Four 30-second periods were used with no rest time between them. The scores are the number of reversals in the first period and the total for the two minutes.

Inverted Alphabet: Starting with the letter A in the lower right hand corner of the page, the S is asked to write each letter, in alphabetic order, upside down and backwards. There were five 30-second trials with 15-second rest period between. Each trial began with the letter A. If the letter Z was reached before time was called, S started the alphabet over again. This test was selected as a learning measure. An attempt was made to find a task on which Ss would be equally inexperienced. The task was scored for the per cent improvement, the number of letters correctly written on the best trial, and the range in the number correct between the worst and best trials. The most errors made on a single trial were also noted.

Embedded Figures Test (EFT): The figures used were adapted from Gottschaldt's by Crook et al (1958). For each of five problems (plus a practice one), a sample figure was shown and beneath it were four complex figures. The subject was told that the sample is embedded in two of the four complex figures and she is to indicate which of the two. One minute was allowed for each problem. The score was the number (out of 10) correctly identified.

From the 1964 test battery:

Necker Cube: The procedure followed was as before: four 30-second periods for which S records the number of reversals. In addition, later in the session (for the women only), S was asked to fixate again on the center of the cube, but to try to slow the number of reversals. The Ss were also asked to make the cube reverse as fast as possible.

Concealed Figures: (French, 1954) is a paper and pencil adaptation by Thurstone of the Figures Test developed in the 1920's by Gottschaldt. For each row of designs the S was to decide whether the figure on the left of the row is embedded in any of the four complex designs on the right. The S was told that the figure is concealed in at least one of the designs and may be in all four. Three pages with seven items on each page were used and five minutes were permitted for the task. Few if any Ss complete the 21 items in that time. Two scores were obtained: the number of items correctly identified and the number correct/number attempted. This test is a variant of the EFT administered as part of the 1962 study. The time allotted here is proportionately much briefer and the task is more complex because S is not told how many "correct answers" exist for each item.

There has been some argument in the literature as to what the task is measuring. It has been argued that "good performance requires the individual to hold the stimulus figure in a perseverative way while searching for forms which match it among an array of potentially distracting elements" (Clark, 1963, p. 25). This implies that this task is a kind of memory test as opposed to a more purely perceptual one. It was our hypothesis that many Ss continually compare the test figure with the complex designs and thus do not hold it in memory. To test this hypothesis, Ss were also given a Sequential Concealed Figures Test. This consisted of nine of the problems that are included in the Thurstone Concealed Figures Test but were not included among the 21 items above. The nine problems were presented in a separate booklet, 2" x 8½". The test figure was always on a separate page and S was allowed five seconds to study it. On the following page were placed the four complex figures and S was permitted ten seconds to select the items he thought contained the test figure. In this way, S was forced to hold in memory the concealed design. Since this was, in effect, a pretest for this type of task the choice of five and ten seconds may have been inappropriate and further testing is needed to ascertain the most comparable conditions for the sequential form of Concealed Figures. The number of correct identifications (out of 36) was the score.

Identical Forms is a test used by Thurstone (1938) in his factorial study of mental abilities. Each item involves matching a given figure at the left of the line, with the one (out of five choices) which is its exact duplicate. The four wrong answers are only slightly different. The S's task was in many ways comparable to his task on Concealed Figures. The difference was that the correct

figure was not embedded in a larger one. Again the issue of whether the best approach is to "hold" the stimulus figure in memory or to rapidly scan back and forth between stimulus and choices arises. Which strategy the subject uses is not known. The test is similar to one called "perceptual speed" in the Guilford-Zimmerman Aptitude Survey. The S was given a minute and a half in which to work on two pages with 20 items on each. The number of correctly identified items was one score for the test.

Gestalt Completion Test, form 1950A (Thurstone, 1944) is an adaptation by Thurstone of Street's original test. It is composed of 24 mutilated pictures which the subject is required to identify. Three minutes were allotted for the task and the number of items correctly identified was the score.

Mutilated Words, form 1950B (Thurstone, 1944). Words are presented with parts of each letter missing. The S was to write out the full word in an adjacent space. Three pages with 17 items on each page were used and four minutes were given for the task. Again the number correct was the score. This test is often found to correlate with the Gestalt Completion Test.

Time estimation: The Ss were instructed to estimate the lengths of five intervals which were 5, 4, 9, 3, and 7 seconds long. The intervals were designated by the words "start" and "stop." To prevent any mechanical means of estimating the intervals, Ss were instructed to write the alphabet backwards starting with the letter Z in the bottom right hand corner and continuing towards A. When the experimenter said "start," X would start with Z on the first trial, or continue where he had left off on the previous trial. When E said "stop," S would indicate the length of time elapsed. This task was scored for the signed and absolute mean per cent error and for the range in per cent errors. Results from previous research led us to expect that time is experienced as elapsing less rapidly for more perseverative people.

Word Fluency: The subject was given one minute in which to write as many words as he could think of. This is an adaptation of the Word Naming Test, from Form L of the Stanford-Binet Intelligence Scale (Terman & Merrill, 1937).

Brick Uses (Guilford, 1959): The subject was instructed to "write down as many uses of a brick as you can" and was given three minutes for the task. These were scored for the number of uses listed, the number of categories these represent, and the number of shifts in categories.

Organization Names is a test we have designed (and have used for the first time in this study) that parallels the WCEN task in certain ways. The subject was asked to compose possible names for organizations whose initials are M P R S , used in that order. Two minutes were given. The test was scored for the number of names produced, the number of different names produced (no more than one word used in a previous name), and the ratio of the number of different words divided by the number of names.

Kurdish-English Paired-Associates (Carroll and Sapon, 1959) consists of 24 pairs which the subject was asked to memorize in the allotted two minutes. The pairs consist of pseudo-Kurdish words and their English equivalents, thus constituting a task much like vocabulary memorization. The S was then given two minutes in which to recall as many of the English equivalents as he can remember for the Kurdish words which were printed on a piece of paper in a different order from the original one. The S was then given three minutes in which to recognize the correct English word from among five alternatives for each of the Kurdish words. The multiple choices had maximum interference in that all choices were words from the original set. For both recall and recognition the number of items identified correctly was the score. Guessing was encouraged.

At the end of the session, about 75 minutes after the items were committed to memory, Ss were again given the recall and recognition tasks, two minutes allotted for each, and the items were again in different orders.

This task, therefore, yielded short-term and long-term memory recall and recognition scores. Since it seems that some Ss improve in their scores while others do not, difference measures were also used. The long-term recall was inserted in the test battery because of the previous work by Kleinsmith & Kaplan (1963, 1964) which makes an improvement in memory over time a not unlikely occurrence.

Word-Number is also a paired associate memory task. The subject is given three minutes in which to memorize 21 pairs each consisting of an object and two digit number. The words are presented in a different order when S was given two minutes in which to supply as many of the numbers as he could. Once again a long-term recall was administered 75 minutes after the original recall, and the words were presented in a different order.

Digit Span (Wechsler, 1958) is a group administration form of the digit span test in the Wechsler Intelligence Scale for Children. The examiner read at a rate of a digit per second, series of numbers of increasing length (from 3 to 9, with two instances of each) and S recorded these digits in proper order after each series is completed. The scores obtained were both the traditional one, the longest correct series before any errors are made, and the longest correct series permitting one error. We have found in the past that some Ss have the capacity for correctly recalling a 9-digit series although they may have erred on a five-digit one.

Estimation Questionnaire: Nineteen of Pettigrew's (1958) 20 questions were used. Each item of this questionnaire consists of a statement defining a given category and the average value for that category, followed by two sets of 4 alternatives, the first set containing numbers greater than the average, the second set consisting of numbers less than the average. The S circles one number from each set, thus indicating his estimate of both extremes for that category. Each item is scored by assigning a value from 0 to 3, where zero

indicates the smallest of the "greater than average" alternatives, and the largest of the "less than average" alternatives. A score of 6 on a given item would thus indicate the greatest range of judgment, while 0 would imply a narrow range of estimation. A total score for the 19 items was used.

APPENDIX C

Alternate Measures and Sex Differences: Supplementary Findings

The detailed description of the tests and measures (Appendix B) lists a variety of scoring procedures or alternate measures that were used. In some cases such alternate measures proved to be so strongly related as to be essentially two ways to measure the same thing. In other cases, they proved to be indeces of quite different strategies or characteristics. From Smallest Space Analyses (SSA-III) where such alternate measures were included in the same analysis, and from inspection of correlations among these variables, the findings which are discussed in this appendix emerge. Three samples are referred to here: the original female sample, N=93; the sub-sample of those who participated in the 1964 study, N=44; and the male sample whose test battery corresponds closely to the 1964 study, N=28. (Correlations are considered significant if they exceed two standard errors from the null hypothesis that the correlation in the population is zero. For the sample sizes indicated, this means coefficients greater than or equal to .21, .30, and .38, respectively.)

Skin resistance - The various skin resistance variables tended to load together on one dimension and no other variable loaded on the same dimension. The correlations among these variables for the original sample ranged from .72 to .90 for all the measures dealing with variability in level. The basal resistance level correlated in the .50's with these, and only .22 with the largest per cent deflection. Basically then, it appears that these measures are strongly interrelated and surprisingly unrelated to any other variable. In the past we have found relationships among energy-related questionnaire items (e.g., "Do you feel full of energy?") and skin resistance measures. These findings were not replicated in this sample.

Inverted Alphabet - For the original sample, the most letters S wrote on her best trial and the most letters she produced correctly on her best trial were virtually the same measure. The range in number of letters correctly produced in the five trials and the per cent improvement score were also virtually the same measure. Range and number of letters produced on the best trial correlated .45. Since none of these measures correlated significantly with the errors made, it comes as no surprise that "errors" did not load on the same dimension as the other inverted alphabet measures.

Memory - Generally, the six memory variables (Word-Number long-term and short-term recall; Kurdish-English long-term and short-term recall and recognition) were highly interrelated. The four Kurdish-English variables correlated between .73 and .87 for both men and women. The two Word-Number variables correlated .92 for the women and .80 for the men. The correlations between the Word-Number and the Kurdish-English variables were somewhat lower, between .40 and .60

for men and women. (Exceptions to these were found with long-term recognition which did not correlate significantly with Word-Number for men or women, and for the male sample, short-term recall for Word-Number and Kurdish-English also did not correlate.) It appears from these results that the particular choice of memory variables matters relatively little and if several memory measures are included in SSA they all load together. For the women, Generation (Anagrams) loaded with memory. The men did not have this measure.

WCEN - For the original sample, number of sentences produced, number of same sentences, number of different sentences (three or four different words), and the ratio of different words to number of sentences, inter-correlated quite highly though "same" and "different" and "ratio" and "number" did not correlate significantly. An SSA on this sample showed the "ratio" to load uniquely on one dimension, while the "number" loaded with Generation, indicating a kind of verbal flexibility. People who produced more WCEN sentences and Generation words, were also found to be ones who said they "cannot listen to a lecture without feeling restless" (Q11).

In SSA of the sub-sample, it was found that the number of different WCEN sentences produced loaded with GPA, OAIS Achiever, systematic problem-solving (Q15), self-description of Organized, Persevering, and Painstaking, and low Gestalt Completion score -- variables that might be considered characteristic of convergent production, while the "ratio" measure, perhaps a creativity index, loaded with high Necker reversal, OAIS Intellectual and Creative, SAT Verbal, and "bothered by useless thoughts" (Q12), possibly a more flexible, divergent production constellation.

Organization Names - Although this task might be considered a close kin to WCEN, none of the variables from the two measures correlated significantly. In the present context, it is impossible to tell if this is due to non-reliability since the two measures were administered one and a half years apart, to differences in the tasks themselves, or to the particular sub-sample participating in the entire study. The two measures obtained from the Organization Names, the number of names produced and the ratio of different words to number of names, behaved quite differently in the male and female samples. For the women, the two measures correlated -.44 and loaded together. For the men, the correlation was .06; "ratio" loaded uniquely and "number of names" loaded with number of shifts in Brick Uses, Concealed Figures, and SAT-Math. (This cluster of items is discussed in Chapter III.)

Brick Uses - Here the three measures obtained - number of uses, number of categories, and number of shifts in categories - were highly interrelated for both men and women (correlations between .70 and .90). It was expected that the "shifts" and "categories" would better reflect divergent performance, while "uses" might be more related to fluency, but since the three measures differentiated little, only "shifts" was used in SSA.

Concealed Figures (CF) - "Per cent" and "number" correct on this test correlated .35 for the women and .68 for the men. CF-"sequential" correlated .44 with EFT (Embedded Figures Test, taken a year and a half before) and .39 with "per cent" for the women, while for the men, "sequential" correlated .37 with "number." Neither EFT, nor CF number, per cent, or sequential loaded on any memory-related dimension as implied by Clark's (1963) hypothesis (see Appendix B). However, for the men, low but significant correlations (between .40 and .48) were obtained between each of the CF variables and some of the paired-associate memory variables. These correlations would lend some support to the memory hypothesis although they do not directly deal with the question of what strategy the person used when performing this task. The fact that no correlations were obtained for Concealed Figures and memory for the females might lead one to postulate that males and females use different strategies in attempting this task. As will be discussed later in this appendix, memory and CF were two instances where significant sex differences were found with women doing better on memory and men doing better on CF.

Digit Span - The two digit span measures correlated .39 for women and .48 for men and loaded on the same dimension in each case. For both men and women, the mean digit span to the first error was around 7 digits and the mean longest span was between 8 and 9 (the longest span tested). For men, the longest correct span correlated between .39 and .44 with CF-sequential, Kurdish-English long-term recall, Word-Number short-term recall, and GPA, again suggesting that men and women use somewhat different strategies since for the women no relationship was obtained between digit span and any of the memory-related variables.

Time Estimation - The findings for this task proved disappointing. For the men, time estimation loaded on its own unique dimension with no other variables. For the women, there was some indication that accuracy and over- vs. under-estimation are separate dimension, though neither seems much related to other variables. Over-estimators (female) seem to get higher scores on Gestalt Completion. Female Ss who judge time more accurately seem to be somewhat less reactive in skin resistance pattern and have better recognition scores on Kurdish-English. Though significant, none of these correlations is greater than .42.

Necker - 1. For the subsample performing this task one and a half years apart, correlations of .71 and .61 were obtained between the scores for the first 30-second period and for the entire two minutes, respectively, even though the task was individually administered the first time and group administered the second time.

2. For both men and women, the second 30-second period correlated more highly with the two minute total than did the first 30-second period, though the latter and the two-minute total correlated .85.

3. For the regular Necker administration and for Necker-fast ("make the cube reverse as fast as possible") the first 30-second period correlated with the two-minute total .87 and .93, but for Necker-slow ("see how slowly you can make it reverse"), the comparable correlation was only..58. Similarly, for the first 30-second period, the Necker scores between "regular" and "fast" correlated .83 and between "slow" and "regular" and "slow" and "fast" they correlated in the high .60's. For the second 30-second period, "fast" and "regular" correlated .65, but "slow" did not correlate significantly with either of these. What all this points to is that making the reversals slow down involves something different and that it takes some time before S can achieve this slowing down (correlation between first and second 30-second period is .26 for "slow" and .88 for "fast"). It also appears that Ss with relatively high "regular" and "fast" Necker scores are not necessarily the ones with high "slow" scores. (Only the 44 women participated in this, and later results with more than 90 women tend to replicate these findings.)

4. The SSA results for the female sample thus were not surprising: the two-minute total score for "fast," "regular," and for the 1962 administration, all loaded on the same dimension. "Bothered by useless thoughts" (Q12) and poor per cent improvement on Inverted Alphabet also loaded on this dimension. Necker "slow," by contrast, loaded on a different dimension together with Word fluency, Brick shifts, and self-reported Imaginative and Humorous. These latter variables represent what we had thought Necker would relate to, suggesting that perhaps those Ss who against all effort cannot keep the fluctuations down are the ones with a "truly" high Necker score.

5. The mean two-minute total score for Necker "fast" was 69.6, and for Necker "regular", 46.8 (an increase of 49%), while for Necker "slow" the mean was 20.7 (a decrease of 56% from the "regular" rate). Differences between these means are highly significant (t= 2.09 and 5.05, respectively, with 43 degrees of freedom).

Sex differences - For the majority of the variables discussed in this section, the differences in the means of the male and female samples were not significant. Exceptions to this were found for the following variables (with 70 degrees of freedom, t= 2.00 is significant at .05, and t= 2.65 is significant at .01):

Women had higher scores on Kurdish-English long-term recall (t =2.71) and while men scored the same on short-term and long-term recall, women did proportionately better on long-term than short-term.

Men did better on Concealed Figures, using number correct, per cent correct, or sequential as the index (t= 4.37, 2.58, and 2.96, respectively).

Women's mean percent error in time estimation was significantly different from men's, in the direction of more over-estimation on the part of men and more under-estimation for women (t= 2.15).

The difference in GPA, SAT verbal and mathematics, and the three OAIS scales were not significant and encourage one to think that the two sample were relatively comparable.

APPENDIX D

Dimensional Solution - Female Sample
(Guttman-Lingoes SSA-III)

(Loadings are listed in order of decreasing magnitude; minimum loading reported is .35. Parentheses indicate that the variable loaded more strongly on another dimension. "Q14" refers to item 14 on Questionnaire, Form C; "A" precedes items from the Adjective Check List. Results are based on N=44.)

Load	Dimension I
.79	A: Energetic
.75	A: Active
.59	Q3: You are the kind of person who is "on the go"
.58	Q7: You feel full of energy
.50	Organization Names - number of names produced
-.49	Q17: Do you prefer not to have many different tasks or duties to look after
-.46	Q25: I do not enjoy having to adapt myself to new and unusual situations
.42	(Q20: You crave excitement)
-.39	(Q8: Do you prefer to do one task at a time and finish it before going on to another, rather than to have several "irons in the fire" at the same time)
-.38	A: Preoccupied

	Dimension II
.71	A: Organized
.71	A: Persevering
.68	A: Thorough
.65	Q15: You find that the best way to solve a problem is to systematically think it through step by step
.61	A: Persistent
.56	A: Methodical
.54	A: Painstaking
-.52	(A: Careless)
.40	Q23: If you have laid aside a problem, do you find that it still keeps coming back to mind

	Dimension III
.74	A: Adventurous
.64	Q2: Compared with most people, you need variety and change
.61	Q16: In general, how curious do you feel you are
.61	A: Headstrong
.57	Q14: You look forward to new experiences
.56	Q20: You crave excitement
.51	A: Daring
.45	(Q21: You readily think of new ideas)
.43	(Q5: You have difficulty learning language vocabulary)
.37	(Q3: You are the kind of person who is "on the go")
.35	(A: Ingenious)

Dimension IV

.86 A: Original
.75 A: Resourceful
.73 A: Imaginative
.55 Q21: You readily think of new ideas
.53 Q6: When you have laid a problem aside you find that you think of new ideas when you return to it
.47 A: Ingenious

Dimension V

.78 Kurdish-English long-term recall
.76 Kurdish-English short-term recall
.66 Word-number short-term recall
-.47 A: Hurried
.37 (Q7: You feel full of energy)

Dimension VI

.78 Q9: You feel uncomfortable about things being left up in the air
.65 Q1: Once you get started on something, you find it difficult to put it down until you are finished
.58 Q8: Do you prefer to do one task at a time and finish it before going on to another, rather than to have several "irons in the fire" at the same time
.38 Q24: I dislike to change my plans in the midst of an undertaking
.38 (Identical Forms)
.37 (Concealed Figures)
-.36 (Q2: Compared with most people, you need variety and change)

Dimension VII

.71 Necker (two minute total)
.70 Q12: You are bothered by having a useless thought come into your mind over and over
.52 Q13: In general, are you disturbed by being interrupted when you study

Dimension VIII

.78 A: Distractable
.55 A: Careless
-.47 Identical Forms
.40 (A: Hurried)
-.37 (Concealed Figures)
.348 Word Fluency

Dimension IX

.68 Q22: You lack the drive necessary to get as much done as other people do
.56 Q4: You find it difficult to concentrate on one thing for a long time at a stretch
-.49 A: Humorous
-.49 (A: Painstaking)
.42 Q19: You have difficulty with jobs that require attention to many details
.36 (Q17: Do you prefer not to have many different tasks or duties to look after)
.36 (A: Preoccupied)

Dimension X

-.81 A: Tense
.49 Digit Span - longest span correctly recorded
-.43 (A: Impatient)
-.41 (A: Anxious)
.40 Q23: If you have laid aside a problem, do you find that it still keeps coming back to mind

Dimension XI

.79 A: Absent-minded
.79 A: Forgetful

Dimension XII

-.69 A: Intelligent
.58 Q18: You are bored
-.46 Concealed Figures
.43 (Q25: I do not enjoy having to adapt myself to new and unusual situations)
.37 (Q21: You readily think of new ideas)

Dimension XIII

-.85 Time estimation - mean per cent error
-.37 Gestalt Completion

Dimension XIV

.78 A: Cautious
-.62 Brick Uses - number of shifts in categories
-.42 (Q17: Do you prefer not to have many different tasks or duties to look after)

Dimension XV

-.79 Category Width
.42 A: Anxious

Dimension XVI

.74 A: Complaining
.43 (Q18: You are bored)

Dimension XVII

.54 A: Alert
.66 A: Deliberate

Dimension XVIII

.62 Q10: Do you do better by thinking straight through a problem from start to finish rather than frequently dropping it and taking it up again later
.46 A: Impatient
.39 (A: Methodical)
.38 (Organization Names)

Dimension XIX

.75 Mutilated Words
.45 Q5: You have difficulty learning language vocabulary
.37 (Q10: Do you do better by thinking straight through a problem from start to finish rather than frequently dropping it and taking it up again later)

Dimension XX

.79 Q11: You can listen to a lecture without feeling restless
.35 Q14: You look forward to new experiences

NB: 1. The variable A: Wide Interests was included in the matrix but did not load at $\geq .35$.
2. Dimensions I, II, III, IV, VI, and XVIII are reported with signs of the loadings reversed for ease of interpretation.

APPENDIX E

Dimensional Solution - Male Sample
(Guttman-Lingoes SSA-III)

(Loadings are listed in order of decreasing magnitude; minimum loading reported is .35. Parentheses indicate that the variable loaded more strongly on another dimension. "Q14" refers to item 14 on Questionnaire, Form C; "A" precedes items from the Adjective Check List. Results are based on N=28.)

Load	Dimension I
.90	A: Organized
.81	A: Cautious
.80	A: Methodical
-.70	A: Complaining
.67	A: Deliberate
.60	A: Painstaking
-.57	A: Absent-minded
.48	Q1: Once you get started on something, you find it difficult to put it down until you are finished
-.45	A: Forgetful
-.41	(A: Careless)
.39	(Q15: You find that the best way to solve a problem is to systematically think it through step by step)
-.37	(Q4: You find it difficult to concentrate on one thing for a long time at a stretch)
.36	(Q11: You can listen to a lecture without feeling restless)
-.36	(A: Daring)

	Dimension II
.89	A: Imaginative
.85	A: Ingenious
.81	A: Original
.71	Q21: You readily think of new ideas
.65	A: Wide interests
.62	A: Resourceful
.57	A: Humorous
.50	(A: Intelligent)
-.38	(Word-number short-term recall)
.36	(A: Alert)

Dimension III

.89 A: Anxious
.88 A: Tense
.72 A: Hurried
-.45 A: Daring
.45 (A: Forgetful)
.41 (A: Persistent)
.39 (Q7: You feel full of energy)
.39 (Q1: Once you get started on something, you find it difficult to put it down until you are finished)
.37 (A: Persevering)
.36 (Q12: You are bothered by having a useless thought come into your mind over and over)

Dimension IV

.70 Q12: You are bothered by having a useless thought come into your mind over and over
.68 Q19: You have difficulty with jobs that require attention to many details
.68 Necker (first 30 seconds)
.65 Q24: I dislike to change my plans in the midst of an undertaking
-.63 Q11: You can listen to a lecture without feeling restless
.55 A: Distractable
.54 Q4: You find it difficult to concentrate on one thing for a long time at a stretch
.38 (Organization Names)
.37 (Q18: You are bored)

Dimension V

.89 Q23: If you have laid aside a problem, do you find that it still keeps coming back to mind
.76 Q8: Do you prefer to do one task at a time and finish it before going on to another, rather than to have several "irons in the fire" at the same time
.60 Q9: You feel uncomfortable about things being left up in the air
.55 A: Persevering
-.43 (Q5: You have difficulty learning language vocabulary)
-.42 A: Preoccupied
.37 (A: Adventurous)

Dimension VI

.84 Mutilated Words
.82 Gestalt Completion
.60 Identical Forms
.56 Word Fluency
-.54 Q17: Do you prefer not to have many different tasks or duties to look after
.46 A: Impatient
.43 (Concealed Figures)
.41 (Organization Names)
.38 (Brick Uses - number of shifts in categories)
.36 (Q7: You feel full of energy)

Dimension VII

.83 A: Energetic
.67 A: Active
.63 Q7: You feel full of energy
.48 Q6: When you have laid a problem aside you find that you think of new ideas when you return to it
.41 (A: Alert)
.41 (A: Hurried)
.38 (Q14: You look forward to new experiences)
-.37 (Q18: You are bored)
.37 (Q3: You are the kind of person who is "on the go")

Dimension VIII

.84 Q20: You crave excitement
.70 Q14: You look forward to new experiences
.52 A: Adventurous
.44 Q18: You are bored
.37 (Q3: You are the kind of person who is "on the go")
.37 (Q5: You have difficulty learning language vocabulary)

Dimension IX

.89 Kurdish-English short-term recall
.81 Kurdish-English long-term recall
-.35 (Q18: You are bored)

Dimension X

.91 SAT - mathematics
.69 Concealed Figures
.60 Brick Uses - number of shifts in categories
.48 Organization Names
.41 (Necker - first 30 seconds)
-.36 (A: Humorous)

Dimension XI

.83 Q10: Do you do better by thinking straight through a problem from start to finish rather than frequently dropping it taking it up again later
.63 Q15: You find that the best way to solve a problem is to systematically think it through step by step
-.43 (Q17: Do you prefer not to have many different tasks or duties to look after)
-.35 (Q6: When you have laid a problem aside you find that you think of new ideas when you return to it)

Dimension XII

-.70 Digit Span - longest span recorded
.65 A: Alert
.50 Q5: You have difficulty learning language vocabulary
-.37 (Q24: I dislike to change my plans in the midst of an undertaking)

Dimension XIII

-.77 Category Width
.70 Q13: In general, you are disturbed by being interrupted when you study
-.60 A: Intelligent
.43 (Q17: Do you prefer not to have many different tasks or duties to look after)
.38 (Q15: You find that the best way to solve a problem is to systematically think it through step by step)

Dimension XIV

.77 A: Headstrong
.47 A: Careless
.39 (A: Preoccupied)

Dimension XV

.86 A: Thorough
.38 (A: Painstaking)

Dimension XVI

.82 Q16: In general, how curious do you feel you are
-.42 A: Persistent
-.40 Q2: Compared with most people, you need variety and change
.39 (Word Fluency)
.35 (A: Absent-minded)

Dimension XVII

.89 Q22: You lack the drive necessary to get as much done as other people do
.38 (Q5: You have difficulty learning language vocabulary)

Dimension XVIII

.74 Q3: You are the kind of person who is "on the go"
.51 (Q9: You feel uncomfortable about things being left up in the air)

Dimension XIX

-.87 Time estimation - mean per cent error

Dimension XX

.43 Word-Number short-term recall

NB: 1. Dimensions I, II, III, V, IX, and XI are reported with signs of the loadings reversed for ease of interpretation.

APPENDIX F

Dimensional Solution - Test-Retest Data
(Guttman-Lingoes SSA-III)

(The items included in this analysis are all the questionnaire items from the 1962 and 1964 administrations of Questionnaire Form C and 22 of the items from the Adjective Rating Form which was also administered in 1964. The loadings are listed in order of decreasing magnitude in the 1964 column; minimum loading reported is .350. Parentheses indicate that the variable loaded more strongly on some other dimension. An "X" indicates that the corresponding item from the other administration failed to load on the same dimension. Results are based on N=44 females.)

1964	1962	
		Dimension I
.68	.72	Q9: You feel uncomfortable about things being left up in the air
.68		A: Methodical
.63		Q24: I dislike to change my plans in the midst of an undertaking
.48	.66	Q8: Do you prefer to do one task at a time and finish it before going on to another, rather than to have several "irons in the fire" at the same time
.47	.75	Q15: You find that the best way to solve a problem is to systematically think it through step by step
.38		A: Thorough
(.37)		(A: Organized)
.36	X	Q1: Once you get started on something, you find it difficult to put it down until you are finished
		Dimension II
.85		A: Original
.81		A: Imaginative
.64	.65	Q21: You readily think of new ideas
.57	(.44)	Q6: When you have laid a problem aside you find that you think of new ideas when you return to it
.53		A: Resourceful
.36		A: Humorous
		Dimension III
.80	.61	Q14: You look forward to new experiences
.76		A: Adventurous
.60	.41	Q2: Compared with most people, you need variety and change
.55	(.38)	Q20: You crave excitement
.41	X	Q16: In general, how curious do you feel you are

1964	1962	
		Dimension IV
-.66	-.50	Q4: You find it difficult to concentrate on one thing for a long time at a stretch
.58		A: Painstaking
-.57	-.51	Q22: You lack the drive necessary to get as much done as other people do
X	-.74	Q19: You have difficulty with jobs that require attention to many details
X	.52	Q6: When you have laid a problem aside you find that you think of new ideas when you return to it
X	.43	Q1: Once you get started on something, you find it difficult to put it down until you are finished
		Dimension V
.77	X	Q3: You are the kind of person who is "on the go"
-.77	X	Q17: Do you prefer not to have many different tasks or duties to look after
.57		A: Active
.46		A: Reliable
X	-.46	Q16: In general, how curious do you feel you are
(.38)		(A: Resourceful)
		Dimension VI
.80		A: Hurried
.68		A: Impatient
.35		A: Stubborn
(.37)	(.52)	(Q5: You have difficulty learning language vocabulary
		Dimension VII
.88		A: Intelligent
X	-.62	Q5: You have difficulty learning language vocabulary
.44		A: Organized
		Dimension VIII
X	.68	Q3: You are the kind of person who is "on the go"
X	.51	Q20: You crave excitement
.51		A: Distractable
(.49)	X	(Q6: When you have laid a problem aside you find that you think of new ideas when you return to it)
X	(.37)	(Q14: You look forward to new experiences)
		Dimension IX
.71		A: Complaining
.44	.72	Q18: You are bored
X	(.45)	(Q22: You lack the drive necessary to get as much done as other people do)
(.38)		(A: Distractable)
		Dimension X
-.65		A: Inhibited
.58	.68	Q23: If you have laid a problem aside do you find that it still keeps coming back to mind

1964	1962	
		Dimension XI
.80		A: Persevering
-.45	X	Q5: You have difficulty learning language vocabulary
(.44)		(A: Reliable)
(.41)		(A: Organized)
X	(-.40)	(Q2: Compared with most people, you need variety and change)
(.37)	X	(Q15: You find that the best way to solve a problem is to systematically think it through step by step)
		Dimension XII
.78	X	Q7: You feel full of energy
(.48)		(A: Resourceful)
(.42)	X	(Q20: You crave excitement)
		Dimension XIII
(.42)	.77	Q12: You are bothered by having a useless thought come into your mind over and over
X	.50	Q17: Do you prefer not to have many different tasks or duties to look after
.36	X	Q1: Once you get started on something, you find it difficult to put it down until you are finished
.35	X	Q13: In general, are you disturbed by being interrupted when you study
		Dimension XIV
.80		A: Cautious
.52	X	Q12: You are bothered by having a useless thought come into your mind over and over
X	(-.41)	(Q1: Once you get started on something, you find it difficult to put it down until you are finished)
		Dimension XV
X	.65	Q10: Do you do better by thinking straight through a problem from start to finish rather than frequently dropping it and taking it up again later
X	.56	Q13: In general, are you disturbed by being interrupted when you study
		Dimension XVI
.50	.73	Q11: You can listen to a lecture without feeling restless
		Dimension XVII
.62	X	Q10: Do you do better by thinking straight through a problem from start to finish rather than frequently dropping it and taking it up again later
.60		A: Relaxed
		Dimension XVIII
.58	X	Q19: You have difficulty with jobs that require attention to many details
(.37)	X	(Q9: You feel uncomfortable about things being left up in the air)

NB: 1. Two variables did not load at ⩾.35: A: Absent-minded; Q7 (1962): You feel full of energy

2. All <u>but</u> the following dimensions are reported with signs of the loadings reversed for ease of interpretation: II, IV, VI, X, XIV, XVI, XVII.

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